California INSTRUMENTS

Invertron® AC POWER EQUIPMENT

An affiliate of Amstar CORPORATION

California Instruments

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California INSTRUMENTS

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INSTRUCTION MANUAL

MODEL 815T

Invertron®

TABLE OF CONTENTS

		PAGE
GENERAL DESCRIPTION		
1.1	INTRODUCTION	1
1.2	MODEL NUMBER DESCRIPTION	1
1.3	GENERAL DESCRIPTION	1
1.4	ACCESSORY EQUIPMENT	1
INSTALLATION AND OPERATION		
2.1	UNPACKING	3
2.2	POWER REQUIREMENTS	3
2.3	FUSE REQUIREMENTS	3
2.4	ACCEPTANCE TEST PROCEDURE	3
2.5	MECHANICAL INSTALLATION AND WIRING	4
2.6	OPERATING CONTROLS	4
THEORY OF OPERATION		
3.1	DESCRIPTION OF SINGLE PHASE OSCILLATOR	6
3.2	GENERAL DESCRIPTION OF SINGLE PHASE TO MULTIPHASE CONVERTER	9
ADJUSTMENT PROCEDURE		
4.1	GENERAL	13
4.2	TEST EQUIPMENT REQUIRED	13
4.3	ADJUSTMENT PROCEDURE FOR WIEN BRIDGE OSCILLATOR	13
4.4	PHASE ADJUSTMENTS FOR MODEL 815T-FREQ-TOL-2ϕ TWO PHASE OSCILLATOR	14
4.5	PHASE ADJUSTMENTS FOR MODEL 815T-FREQ-TOL-3ϕD THREE PHASE, OPEN DELTA OSCILLATOR	15
4.6	PHASE ADJUSTMENTS FOR MODEL 815T-FREQ-TOL-3ϕ THREE PHASE OSCILLATOR	15

SPECIFICATIONS

All specifications are tested in accordance with standard California Instruments test procedures. All specifications apply over the frequency range from 45Hz to 10KHz. Consult the manual addendum for the actual oscillator output frequency.

MODEL NUMBER:	815T-Freq-.1-1	815T-Freq-.1-3*	815T-Freq-.1-2
No. of Phases:	single phase	three phase	two phase
Nominal Phase Shigt:	Not applicable	± 120 degrees	+ 90 degrees
Phase Sequence:	Not applicable	ABC sequence	CA sequence
Amplitude Tracking: (with amplitude potentiometer adjusted from 75% of full output to full output)**	Not applicable	1.0 per cent of full scale	1.0 per cent of full scale
Phase Accuracy at 25°C: (with amplitude potentiometer adjusted from 75% of full output to full output)**	Not applicable	±1.0 degree maximum.	±1.0 degree maximum.

SPECIFICATIONS COMMON TO ALL MODELS

Frequency	Single Fixed Frequency, 45Hz to 10KHz.
Frequency Accuracy at 25°C:	±0.10 percent.
Frequency Temperature Coefficient:	±.02 percent/°C maximum
Output Amplitude:	5.0 volts rms minimum for single phase versions; 0 to greater than 5 volts rms for multiphase versions.
Amplitude Stability: (after one hour warm-up)	±0.25 percent for 24 hours at 25°C ±0.02 percent/°C maximum
Total Harmonic Distortion:	0.2 percent maximum

Input Power:	±25 volts DC at approximately 18 milliamperes available from power source for single phase versions: ±25 volts DC at approximately 55 milliamperes available from power source for three phase versions.
Operating Temperature Range:	0 to 55°C for all versions.
Dimensions:	3-1/2" high x 8" wide x 7" deep for mounting into a California Instruments Solid State Invertron®.
Front Panel Finish:	Grey 26440. Federal Standard 595.

* Order Model 815T-Freq-.1-3D for use in the three phase open delta configuration.

** This is a new improved specification. Oscillators manufactured prior to October 1974 were specified at 2% amplitude tracking with the AMPLITUDE control fully clockwise and 2° phase error with the AMPLITUDE control fully clockwise. These early oscillators were not specified as to additional phase and amplitude tracking errors when the AMPLITUDE control was turned counter clockwise from the fully clockwise position.

Step 5.6.4 was added to this manual at the "D" Revision to test for these improved characteristics in oscillators manufactured after October, 1974.

GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information on the installation, operation, calibration and maintenance of the California Instruments 815T Series Precision Oscillators. A detailed theory of operation is provided as an aid to maintenance personnel. A complete parts listing, schematics and component location drawings are also supplied.

1.2 MODEL NUMBER DESCRIPTION

All oscillators in the 815T Series have a four or five place model number which describes the following features: the oscillator series, the output frequency of the oscillator, the frequency tolerance of the oscillator, and the number of phases of the oscillator. In addition, a "D" is placed after the model number if the oscillator is to be used in the three phase, open delta configuration. The following examples illustrate this numbering system.

Example 1: 815T-400-0.1-3ϕ

This is a 400 Hz, three phase oscillator with a specified frequency accuracy ±0.1%

Example 2: 815T-50-0.1-3ϕD

This is a 50 Hz, three phase oscillator for use in the open delta configuration with a specified frequency accuracy of ±0.1%

1.3 GENERAL DESCRIPTION

The California Instruments 815T Series Oscillators provide a pure sine wave output for driving the California Instruments Solid State Invertrons.® This oscillator incorporates a unique F.E.T. amplitude regulator circuit.

The multi-phase versions of the 815T Series Oscillators are used to drive two or more Solid State Invertrons® connected so as to provide either two phase or three phase power.

1.4 ACCESSORY EQUIPMENT

The following equipment is available for use with the 815T Series Oscillators.

1.4.1 4800-703 Extender Assembly. This assembly allows the oscillator to be tested and adjusted outside of the associated Solid State Invertron®.

CAUTION

HIGH VOLTAGE

Voltages up to 500 VAC are available in certain associated Invertrons®. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with connector pins C and D of the plug in oscillator, the primary power circuits, and output circuits of the associated Invertron® if oscillator is tested and adjusted with Invertron®.

INSTALLATION AND OPERATION

2.1 UNPACKING

Individual oscillators are shipped in a cardboard container with protective inner packing. Do not destroy this packing container until the unit has been inspected for possible damage in shipment.

2.2 POWER REQUIREMENTS

Single phase versions of the California Instruments 815T Oscillator operate from plus (+) and minus (-) 25 volts DC at 0.018 amperes. This power is normally obtained from the associated Invertron.® Three phase versions of the 815T Oscillator require approximately 55 milliamperes at ± 25 volts D.C.

2.3 FUSE REQUIREMENTS

No separate fuse is required with the California Instruments 815T Series Precision Oscillators.

2.4 ACCEPTANCE TEST PROCEDURE

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. DO NOT return an instrument to the factory without prior approval. If the unit appears in good condition, perform the following:

Mount the oscillator in the appropriate rack housing or otherwise apply ± 25 volt DC power to the unit.

2.4.1 MODEL 815T-Freq-Tol-1φ FIXED FREQUENCY OSCILLATOR

Figure 5-1 shows a test circuit for the 815T Series Oscillators. The output of this single phase oscillator should be 5.0 volts rms minimum. Connect an oscilloscope to the output of the oscillator and check that the oscillator has a clean sine wave output with no clipping or other distortion. Check that the output frequency is within 0.1 per cent of that indicated in the manual addendum. Detailed test procedures are given in the TEST PROCEDURE of this manual if futher evaluation of the oscillator is required at this time.

2.4.2 MODEL 815T-Freq-Tol-3φ FIXED FREQUENCY OSCILLATOR

The output of this three phase oscillator is controlled by the front panel AMPLITUDE control. Rotate this control fully clockwise. The output amplitude of each phase of the oscillator should be at least 5 volts rms. See Figure 5-1 for a detailed test circuit.

Connect an oscilloscope to the output of the oscillator and check that each phase of the oscillator has a clean sine wave output with no clipping or other distortion. Check that the output frequency is within 0.1 per cent of that indicated in the manual addendum. Detailed test procedures are given in the TEST PROCEDURE of this manual if further evaluation of the oscillator is required at this time.

2.4.3 MODEL 815T-Freq-Tol-2φ FIXED FREQUENCY OSCILLATOR

The output of this two phase oscillator is controlled by the front panel AMPLITUDE control. Rotate this control fully clockwise. The output amplitude of each phase of the oscillator should be at least 5 volts rms. See Figure 5-1 for a detailed test circuit.

Connect the oscilloscope to the output of the oscillator and check that both phases of the oscillator have a clean sine wave output with no clipping or other distortion. Check that the output frequency is within 0.1 per cent of that indicated in the manual addendum. Detailed test procedures are given in the TEST PROCEDURE of this manual if further evaluation of the oscillator is required at this time.

2.5 MECHANICAL INSTALLATION AND WIRING

The 815T Series Precision Oscillators fit directly into the California Instruments Solid State Invertron® Series of power amplifiers. All power for the oscillator, as well as signal output, is coupled through the printed circuit connector at the rear of the oscillator. The following table lists the voltage and applicable connector pins.

Pin	Function	
1	Output signal low	Phase A
2	Output signal high	Phase A
3	Power Ground	
4	+25 volt input	
5	-25 volt input	
6	Output signal low	Phase B
7	Output signal high	Phase B
8	Output signal low	Phase C
9	Output signal high	Phase C
10	External sync input	
C	115 volts AC line high	
D	115 volts AC line low	

The single phase version of the 815T Series Oscillator only has an "A" phase output. The two phase version of the 815T Series Oscillator has an "A" and "C" phase output while the three phase version of this oscillator has all three outputs. The external sync input and 115 volt AC inputs are not used for the standard versions of this oscillator.

2.6 OPERATING CONTROLS

Single phase versions of the 815T oscillator have no front panel operating controls. Multiphase versions of this oscillator have an AMPLITUDE control which is used to vary the output voltage level of all phases of the oscillator from 0 volts to greater than 5.0 volts rms.

In a multiphase power source, the GAIN control on each of the associated power amplifiers is used as a trim control to adjust each of the output leg voltages so that they are precisely equal to each other.

CAUTION

REMOVE POWER FROM
CALIFORNIA INSTRUMENTS
SOLID STATE INVERTRON
BEFORE REMOVING OR
INSERTING PLUG-IN
OSCILLATOR

THEORY OF OPERATION

3.1 DESCRIPTION OF SINGLE PHASE OSCILLATOR

A block diagram for the basic single phase oscillator in the 815T Series is given in Figure 3-1. A schematic diagram for the oscillator printed circuit board (designated as the A1 Assembly) is given in drawing D4815-071. An inner connecting wiring diagram is given in drawing D4815-070 for single phase, two phase and three phase versions of this oscillator.

The frequency determining elements are arranged in a Wien bridge configuration which is connected as a positive feedback loop around an operational amplifier as illustrated in Figure 3-1. The frequency of oscillation f_o is given by the equation,

$$f_o = \frac{1}{2\pi RC}$$

where R is the total resistance in the positive feedback path and C is the total capacitance in the positive feedback path. At the frequency of oscillation f_o, the positive feedback loop has a transmission of 0.333 and a zero phase shift. The negative feedback loop must adjust the closed loop gain of the operational amplifier A1IC1 to exactly 3.00 in order for the Wien bridge oscillator to produce a pure sine wave output with a minimum of distortion. This is accomplished by means of a servo feedback loop consisting of the level detector, a DC amplifier and the amplitude regulator. Whenever there is a change in the amplitude of the oscillator, a correction signal appears at the output of the level detector circuit. This correction signal is amplified by the DC amplifier and applied to control the output impedance of the amplitude regulator. The output impedance of the amplitude regulator controls the closed loop gain of the operational amplifier A1IC1. Therefore, any variation in the output of the oscillator is corrected by this servo feedback. The detailed circuit description is given in Section 3.1.1.

3.1.1 DETAILED CIRCUIT OPERATION

A schematic diagram for the single phase oscillator is shown in drawing D4815-071. All components of this oscillator are mounted on circuit board 4815-700, designated as the A1 assembly.

3.1.1.1 LEVEL DETECTOR

The level detector consists of A1R13, A1R14, diodes A1CR3, A1CR4, A1CR1, A1CR2, transistor A1Q3 and capacitor A1C9. The series connected reference elements diodes A1CR3, A1CR4 and base-emitter diode of A1Q3 act so as to set the level of the oscillator output. Diode A1CR3 and A1CR4 conduct on the positive peak of the sine wave output and inject a current pulse into the emitter of A1Q3. The average value of this current pulse is approximately 1.6 microamperes DC when the oscillator has a 5.5 volt rms output at A1 pin 15.

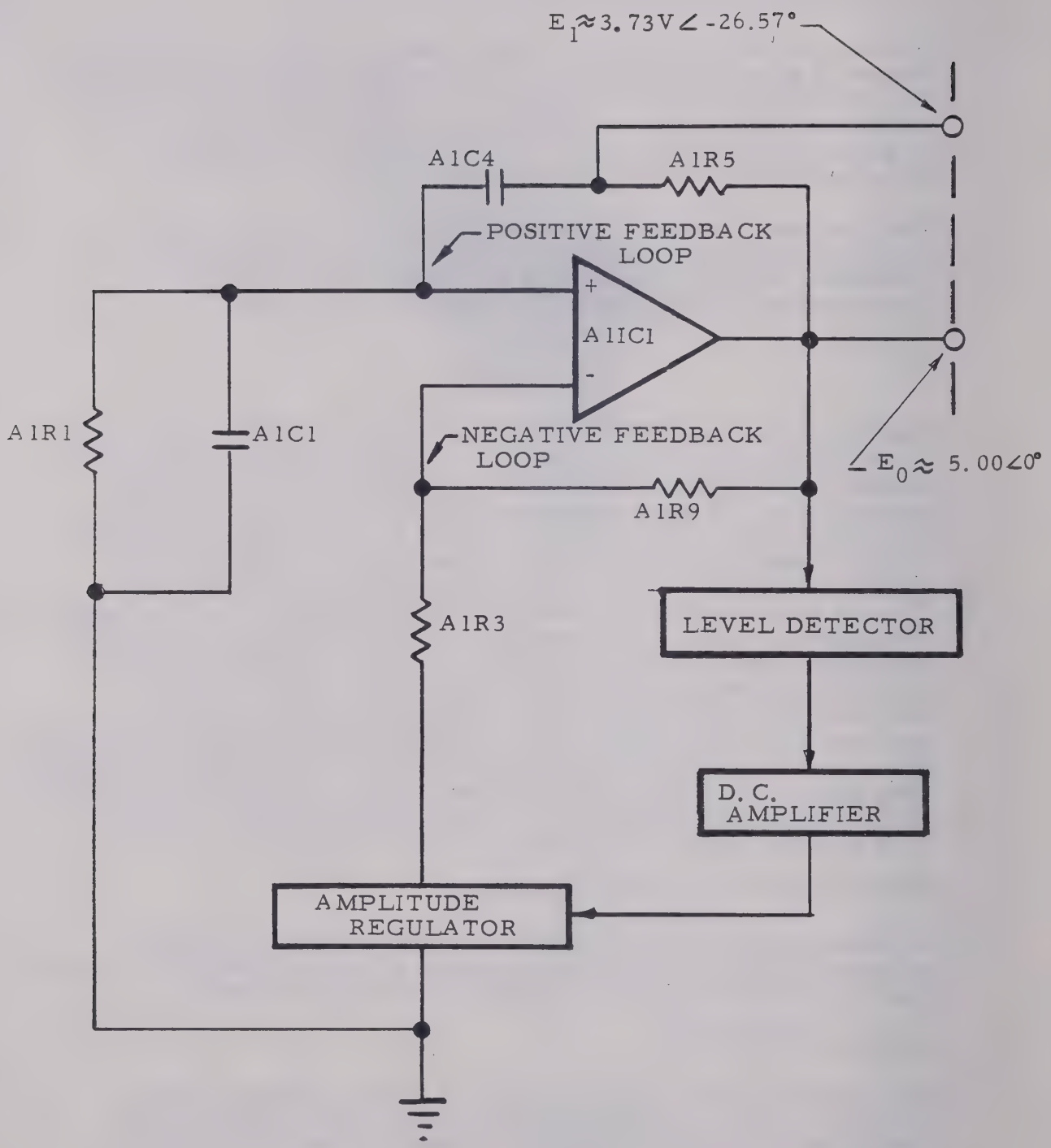


FIGURE 3-1. Block diagram of basic Wien Bridge Oscillator employed in 815T Series Oscillator.

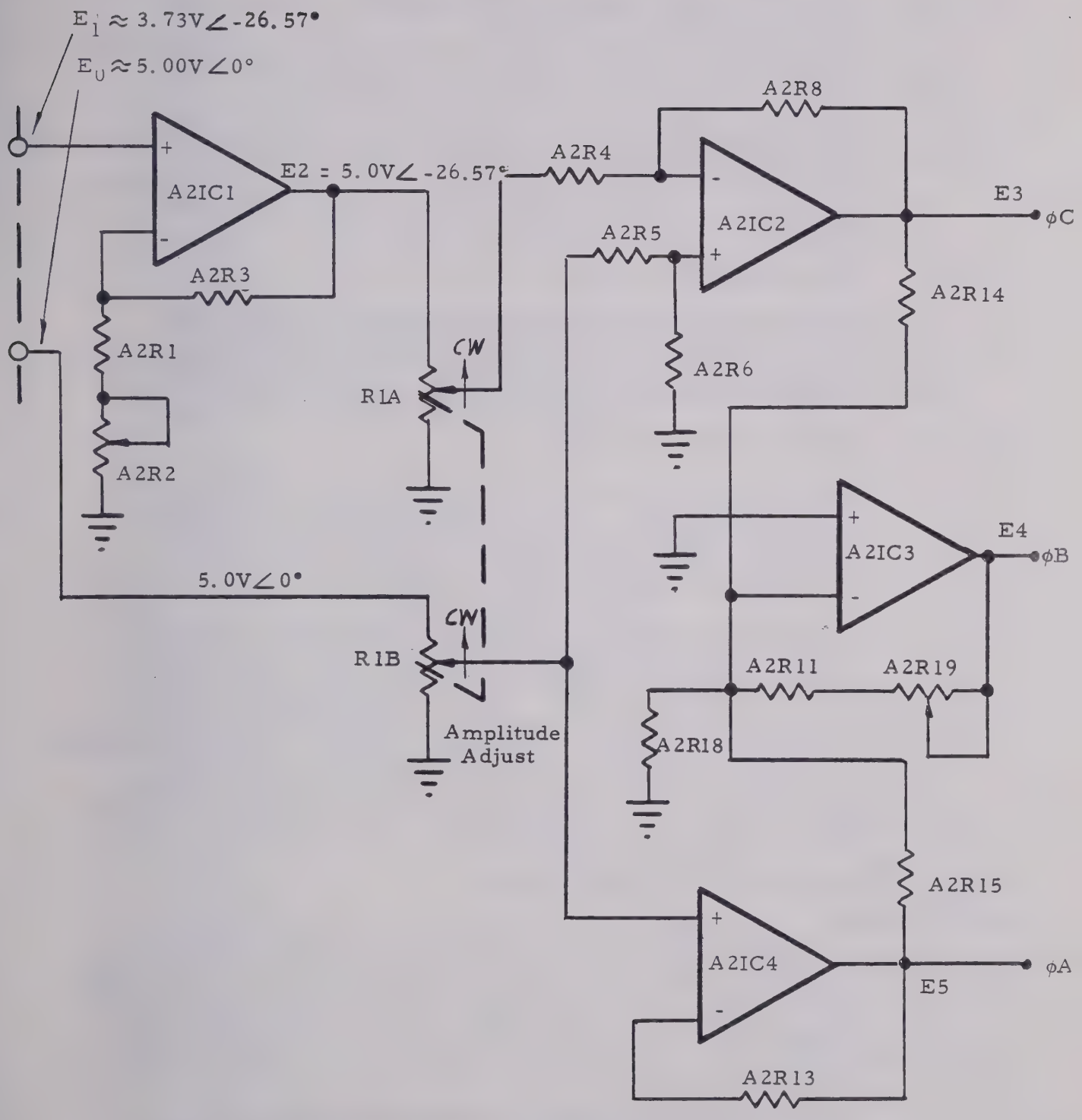


FIGURE 3-2. Block Diagram of Single to Multiphase Converter employed in 815T Series Oscillator.

This current pulse appears in the collector circuit of A1Q3 where it is filtered by capacitor A1C9 to form a DC level across the load circuit, A1R13 in series with A1CR1 and A1CR2. Any variation in the amplitude of the oscillator output will produce a change in the voltage drop across A1C9.

The level detector circuit is temperature compensated by selecting a zener diode A1CR4 with a positive temperature coefficient so as to cancel the negative temperature coefficients of diode A1CR3 and the emitter-base junction of transistor A1Q3.

3.1.1.2 DC AMPLIFIER

Transistor A1Q2 and associated components are connected so as to form a DC amplifier with a small signal gain of approximately five. The signal across A1C9 is amplified and level-shifted for application to the gate of A1Q1.

3.1.1.3 AMPLITUDE REGULATOR

Field effect transistor A1Q1 is connected so as to form an amplitude regulator. The bias at the gate of A1Q1 controls the output impedance (channel resistance) of the amplitude regulator. This output impedance, in turn, controls the closed loop gain of the operational amplifier, A1IC1.

If the sine wave output of the Wien bridge oscillator increases for any reason, the voltage drop across A1C9 also increases, which provides additional base drive to A1Q2. This causes the collector current of A1Q2 to increase and to cause the gate of A1Q1 to be biased more negatively. When the gate of A1Q1 is driven more negatively, the channel resistance of A1Q1 increases. This increase in channel resistance causes the closed loop gain of the operational amplifier A1IC1 to decrease, which in turn decreases the output amplitude of the Wien bridge oscillator and returns it to its original value.

3.2.1 POWER SUPPLY REGULATORS

The power supply regulators allow the oscillator to operate from the unregulated ± 25 volt DC power supply in all California Instruments solid state Invertron® power sources. The oscillator requires ±18 to ± 55 milliamperes with less than 2 volts of peak-to-peak ripple at the input to the regulator. The output of the regulators is ±15 volts ±10 per cent with less than 150 millivolts peak-to-peak ripple.

3.2 GENERAL DESCRIPTION OF SINGLE PHASE TO MULTI-PHASE CONVERTER

A block diagram for the single phase to multi-phase converter is given in Figure 3-2. This circuit employs an analog computer technique of generating the second and third phases of the multi-phase

output. This technique requires no additional tuned circuits and provides the required phase shift independent of oscillator frequency.

The operation of this circuit is dependent on the signal E1 which is available at the junction of the resistive and capacitive elements in the positive feedback loop of the Wien bridge oscillator. A detailed analysis of the basic Wien bridge circuit configuration reveals that the voltage E1 at the frequency of the oscillation f_o is given by:

$$E1 = 0.745\ E0 \angle -26.57°$$

The above equation is valid regardless of the frequency of oscillation. Therefore, it is not necessary to vary these circuit parameters as the frequency oscillator is shifted.

The voltages, E0 and E1, are then processed through a sequence of operational amplifiers to provide the phase "A", phase "B" and phase "C" outputs. The vector diagram below describes how this is accomplished in graphical terms with the AMPLITUDE potentiometer R2 in the fully clockwise position.

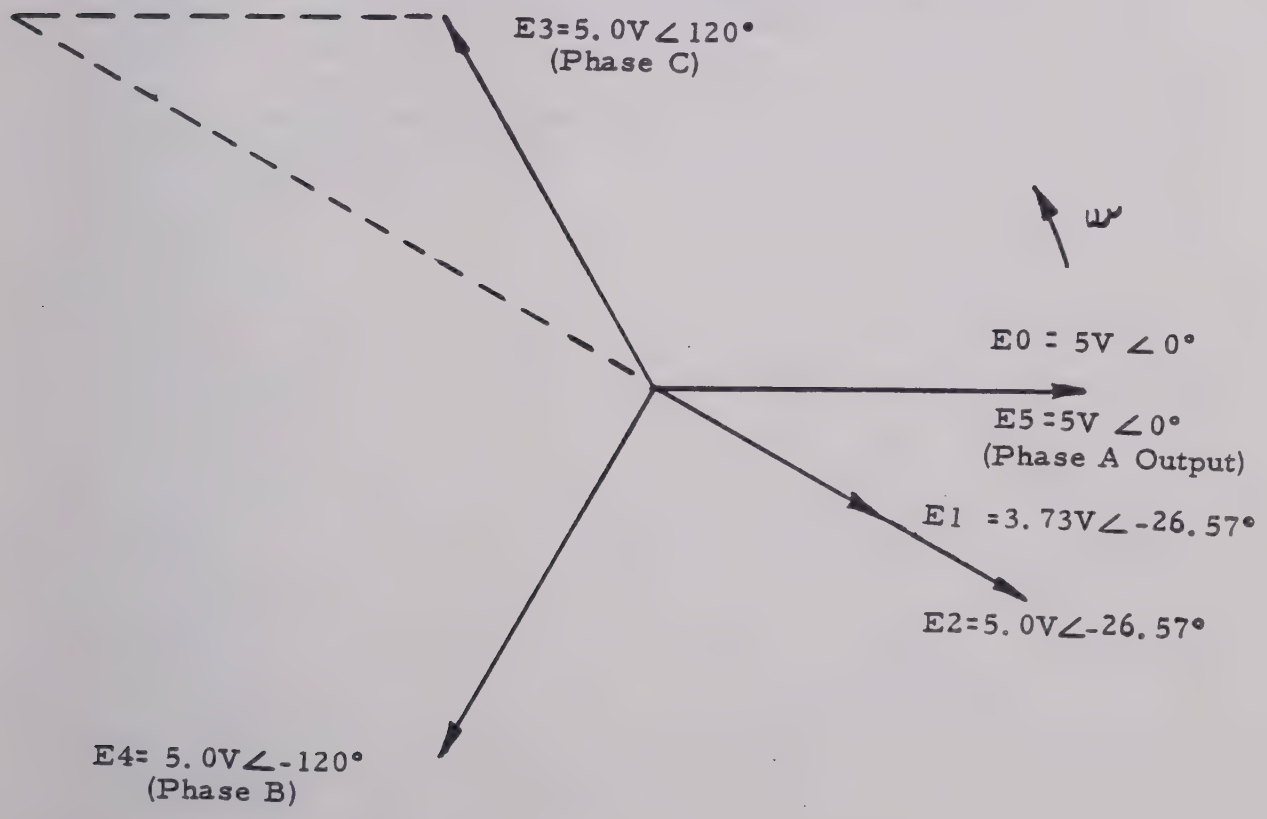


FIGURE 3-3. Vector Diagram for Generation of three-phase Output

First E1 is amplified by a factor of 1.34 to generate E2 at the output of A2IC1. Then E2 is inverted and amplified by a factor of -1.94 by means of the inverting input to A2IC2. The output of the Wien bridge is amplified by a factor of 1.23 with the non-inverting input to A2IC2. The resultant output from A2IC2 provides an E3 (or phase "C") output.

Then E0 is processed through a voltage follower to provide an E5 (or phase "A") output at the output of A2IC4.

Finally, E3 and E5 are added algebraically and then inverted to provide an E4 (or phase "B") output at the output of A2IC3.

For two phase operation, the gain of A2IC2, referenced to the E2 and E0 signals, is changed to -2.245 and 2.01 respectively. This provides a 90 degree phase lead for the phase "C" signal when referenced to the phase "A" signal. The phase "B" signal is not used in this application of the oscillator. For three phase open delta operation, the gain of A2IC2, referenced to the E2 and E0 signals, is changed to -1.94 and 2.24 respectively. This provides a 60 degree phase lead for the phase "C" signal when referenced to the phase "A" signal. The phase "B" signal is not used in this application of the oscillator.

CAUTION

HIGH VOLTAGE (115 AC)

Voltages up to 500VAC are available in certain associated Invertrons®. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with connector pins C and D of the plug in oscillator, the primary power circuits, and output circuits of the associated Inventron® if oscillator is tested and adjusted with Invertron®.

ADJUSTMENT PROCEDURE

4.1 GENERAL

The following adjustment procedure, or any part of it, may be performed on a routine basis to insure that the oscillator remains within the specified performance limits. This procedure should always be followed after any service to the basic oscillator circuitry.

The adjustment procedure is divided into two sections. These are:

1) Adjustment procedure for Wien bridge oscillator.
2) Phase adjustments for single phase to multiphase converter.

4.2 TEST EQUIPMENT REQUIRED

The following test equipment is required to perform the adjustment procedure.

a) Oscilloscope, Tektronix 531A with general purpose plug-in or equivalent.

b) California Instruments Power Source or two H.P. 721A DC Power Supplies or equivalent.

c) Distortion Analyzer, H.P. H02-330B or equivalent.

d) Differential Voltmeter, Fluke 883A or equivalent.

e) Frequency Meter, H.P. 523CR or equivalent.

f) Differential phase meter, DRANETZ 301 or equivalent.

4.3 ADJUSTMENT PROCEDURE FOR WIEN BRIDGE OSCILLATOR

Connect the precision oscillator as shown in Figure 5-1 using either the ±25 volt power supply in the California Instruments Solid State Invertron® or a pair of external +25 volt and -25 volt DC power supplies. Each power supply should draw from 18 to 55 milliamperes. Allow the unit to warm up for one half hour.

4.3.1 Starting with potentiometers A1R2, A1R4 and A1R10, in a fully counter clock wise position, rotate A1R4 slowly in the clockwise direction until the oscillator output just builds up to full output. Rotating A1R4 too far clockwise will cause excessive distortion in the output wave form.

4.3.2 After determining the basic frequency and frequency accuracy of the oscillator from the manual addendum, set the basic Wien bridge oscillator frequency by rotating A1R2 and A1R10 equal amounts in the clockwise direction. The frequency may be monitored with the counter at the integrated circuit A1IC1 pin 6 or at the phase "A" output. The potentiometers A1R2 and A1R10 have sufficient resolution to allow the frequency to be set within 0.05 per cent.

4.3.3 Measure the output amplitude and distortion of the Wien bridge oscillator at the phase "A" output with the differential voltmeter and distortion analyzer. The output amplitude should be between 5 volts and 6 volts rms. The distortion should be less than 0.2 percent. If the phase "A" distortion is excessive, or if the oscillator will not start in a reliable fashion when DC power is applied to the oscillator, perform step 4.3.4 below.

4.3.4 Rotate A1R4 counter clockwise until the output amplitude drops by 1 to 5 percent. Then rotate A1R2 and A1R10 slightly in opposite directions until a peak in the output amplitude is obtained while maintaining the correct output frequency. Reset A1R4 so that the oscillator starts in a reliable fashion when DC power is applied to the oscillator and that the distortion is less than 0.2 per cent.

4.4 PHASE ADJUSTMENTS FOR MODEL 815T-Freq-Tol-2ϕ TWO PHASE OSCILLATOR

4.4.1 Connect the Model 815T-Freq-Tol-2ϕ Oscillator as shown in Figure 5-1 using either the ± 25 volt DC supplies in the California Instruments Invertron® or a pair of external ±25volt DC power supplies. Check that the procedure given in Section 4.3.1 through 4.3.4 of this instruction manual has been performed before proceeding further.

4.4.2 Rotate the front panel AMPLITUDE control fully clockwise. Connect a differential phase meter from the junction of A1R11 and A1R14 to the junction of A2R17 and A2R3. The phase shift must be -26.57 degrees ±0.25 degrees. Parameter unbalance in the basic Wien bridge feedback circuit can cause errors in this phase shift.

4.4.3 Adjust potentiometer A2R2 so that the amplitude of the AC voltage at the junction of A2R3 and A2R17 is equal to the voltage measured at the junction of A1R11 and A1R14.

4.4.4 Monitor the phase "A" output of the oscillator with the differential voltmeter and record the AC output voltage.

4.4.5 Monitor the phase "C" output of the oscillator with the differential voltmeter and record the AC output voltage. The amplitude of the phase "A" and phase "C" output voltages should now correspond within 50 millivolts rms of one another.

4.4.6 Connect the differential phase meter from the phase "A" output to the phase "C" output. Readjust potentiometer A2R2 slightly so that the phase "C" output leads the phase "A" output by 90 degrees ±1 degree and that the amplitude of the phase "A" and phase "C" outputs are within 10 millivolts rms of one another.

4.4.7 Capacitors A2C9 and A2C11 have been installed in the factory for improved phase shift characteristics on certain high-frequency versions of the 815T Series Oscillator.

4.5 PHASE ADJUSTMENTS FOR MODEL 815T-Freq-Tol-3ϕD THREE PHASE, OPEN DELTA OSCILLATOR

4.5.1 Connect the 815T-Freq-Tol-3ϕD oscillator as shown in Figure 5-1 and repeat step 4.4.1 through 4.4.7, except check that the phase shift is 60 degrees ±1 degree.

4.6 PHASE ADJUSTMENTS FOR MODEL 815T-Freq-Tol-3ϕ THREE PHASE OSCILLATOR

4.6.1 Connect the 815T-Freq-Tol-3ϕ oscillator as shown in Figure 5-1 and repeat steps 4.4.1 through 4.4.7, except check that the phase shift is 120 degrees ±1 degree.

4.6.2 Adjust A2R19 so that the phase "B" output amplitude is equal to the phase "A" output amplitude within 10 millivolts rms.

4.6.3 Check that the phase shift of phase "B" referenced to phase "A" is -120 degrees ±1 degree. Capacitor A2C10 (10 pf or less) has been selected at the factory for the best compromise phase shift and amplitude tracking on certain high-frequency versions of this oscillator.

TEST PROCEDURE

5.1 GENERAL

The following test procedure may be performed on a routine basis to insure that the 815T Series Oscillator remains within the specified performance limits. This test procedure is divided into several sections. These are:

1) Output voltage and amplitude stability

2) Harmonic distortion

3) Output frequency and frequency stability

4) Phase accuracy

5.2 TEST EQUIPMENT REQUIRED

The same test equipment is required for the test procedure as was required for the adjustment procedure as given in Section 4.2 of this manual.

5.3 OUTPUT VOLTAGE AND AMPLITUDE STABILITY

5.3.1 Connect the variable frequency oscillator as shown in Figure 5-1 and allow the unit to warm up for one hour in a 25°C environment. In the case of a multiphase oscillator, rotate the AMPLITUDE control fully clockwise.

5.3.2 The output of the oscillator should be measured with differential voltmeter connected to the phase "A" output (Pin 1 and Pin 2 of the printed circuit connector). The output voltage should be between 5.0 volts rms and 6.0 volts rms. Record the exact value of the output voltage.

5.3.3 Measure the phase "A" output voltage in 15 minute increments for two hours. The change in output voltage must not exceed ± 12.5 millivolts rms. This test may be continued for 24 hours if required. Maintain the ambient temperature at 25°C for this test.

5.3.4 Increase the ambient temperature to 50°C and allow the unit to stabilize for one hour. The output should change less than ±25 millivolts rms.

5.4 HARMONIC DISTORTION

Connect the precision oscillator as shown in Figure 5-1 and allow the unit to warm up for a few minutes. In the case of the multiphase oscillators, turn the AMPLITUDE control so that the output from each phase is approximately 5.0 volts rms.

5.4.1 Connect the distortion analyzer between the high output of phase "A" and the ground of phase "A". The distortion should be less than 0.2 per cent if the oscillator frequency is between 45 Hz and 10KHz.

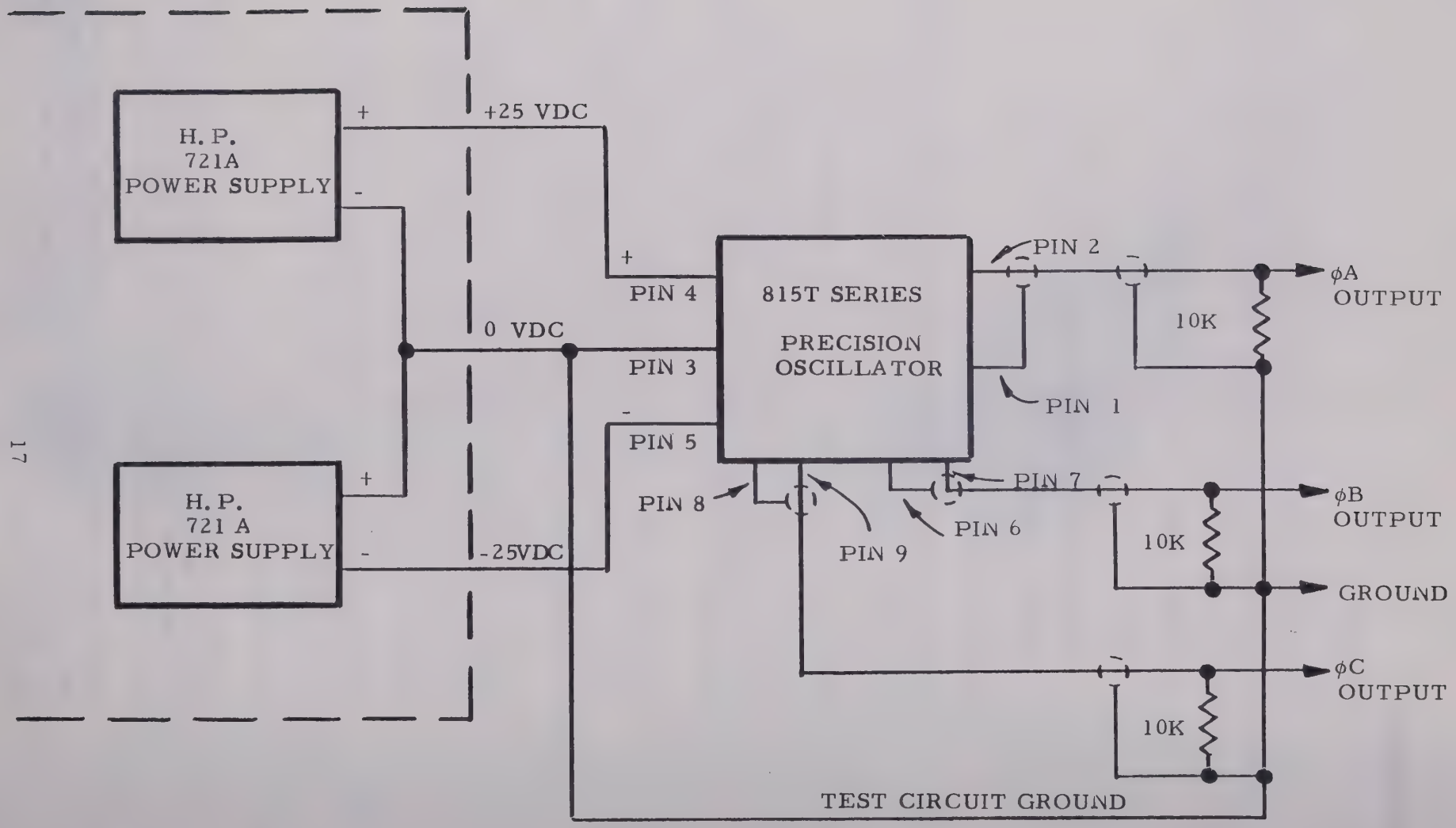


FIGURE 5-1. Test Circuit for 815T Series Oscillators

5.4.2 If the oscillator is a multiphase oscillator, then repeat 5.4.1 for the other phase or phases. The distortion should not exceed that specified in Section 5.4.1

5.5 OUTPUT FREQUENCY AND FREQUENCY STABILITY

Connect the unit as shown in Figure 5-1 and allow the unit to warm-up for one hour in a 25°C environment. The output voltage should be approximately 5 volts rms. Adjust the AMPLITUDE control on the multi-phase oscillator, as required.

5.5.1 Measure the phase "A" output frequency at 25°C with the counter. The frequency of the oscillator should be within ±0.1 percent of that indicated in the manual addendum. Record the frequency for reference in Section 5.5.2 below.

5.5.2 Increase the ambient temperature to 50°C and allow the unit to stabilize for one hour. The output frequency should change less than ±0.5 percent from that indicated at 25°C.

5.6 PHASE ACCURACY

This section of the manual is only applicable to multiphase versions of the 815T Series Oscillator. Connect the oscillator as shown in Figure 5-1 and allow the unit to warm-up for one hour in a 25°C environment.

5.6.1 Rotate the front panel AMPLITUDE control fully clockwise so that the output of phase "A" (Pin 1 and Pin 2 of the printed circuit connector) is greater than 5 volts rms.

5.6.2 Connect a differential phase meter between the phase "A" output and the phase "C" output so that the phase meter reads the phase "C" output referenced to the phase "A" output. The phase meter should indicate +60 ±1 degree for the three phase open delta oscillator; +90 ±1 degree for the two phase oscillator; and +120 ±1 degree for the standard three phase oscillator.

5.6.3 For the standard three phase oscillator, measure the phase shift of the phase "B" output referenced to the phase "A" output. This phase shift must be -120 ±1 degree. If problems are encountered, refer to Section 4.4 through 4.6 of this instruction manual.

5.6.4 Section 5.6.4 applies only to oscillators manufactured after October, 1974. See page ii for further information.
Vary the front panel AMPLITUDE potentiometer from 75 percent of full output to full output and check that all phases track within 50 millivolts rms of each other and that the phase angles remain within the ±1 degree tolerance.

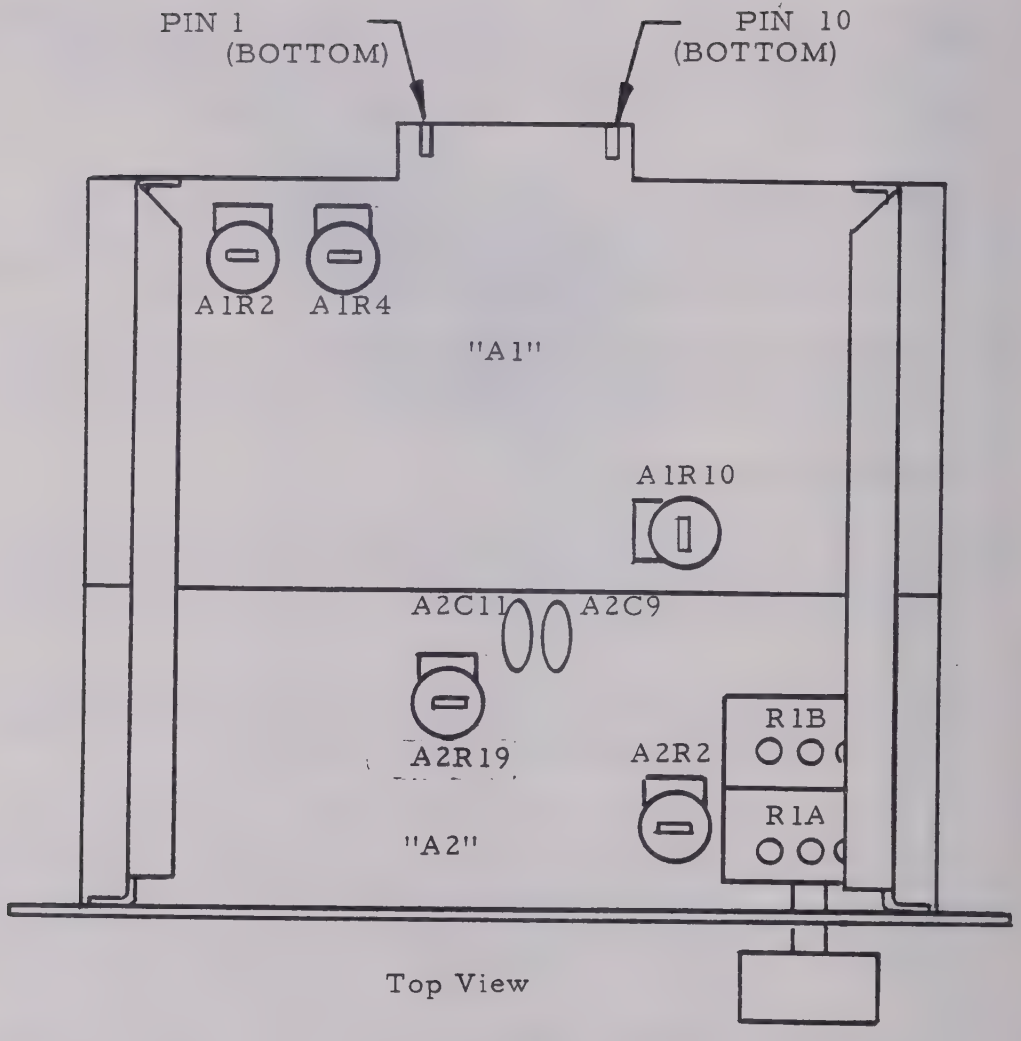


FIGURE 5-2. Locations of Internal Adjustment Potentiometers on Multiphase version of 815T Series Oscillator

MAINTENANCE AND TROUBLESHOOTING

6.1 GENERAL

The California Instruments 815T Series Precision Oscillators are completely solid state and should provide years of trouble-free service. Since the instrument contains no moving parts, periodic maintenance is limited to cleaning in accordance with good commercial shop practices, and a periodic check of frequency accuracy and distortion at six month intervals. If the oscillator is operated in heavy duty applications where severe temperature extremes or mechanical shock are encountered, it is recommended that a more frequent calibration schedule be established.

6.2 TROUBLESHOOTING

6.2.1 Before attempting to repair the oscillator, check that the controls are properly set, that the DC input power is correct and that an excessive load is not connected to the output of the oscillator. Any load impedance less than 5 K ohm per phase should be considered escessive.

6.2.2 Check that the ±15 volt regulator circuits are operating properly and that they have less than 150 millivolts peak-to peak ripple.

6.2.3 Check that the basic Wien bridge oscillator is operating satisfactorily. Detailed information on this circuit is given in Section 3.1 and Section 4.3 in this manual.

6.2.4 Check that the servo feedback loop is operating satisfactorily. Detailed information on this circuitry is given in Section 3.1 of this manual. If the problem appears to be in this area, disconnect transistor A1Q2 and apply -1 to -2 volt DC bias to the gate of A1Q1. This opens the servo feedback loop and allows servicing of this circuitry by conventional signal tracing methods.

6.2.5 If the problem is in the single phase to multiphase converter, the circuit may be checked by conventional signal tracing methods.

CIRCUIT DIAGRAM

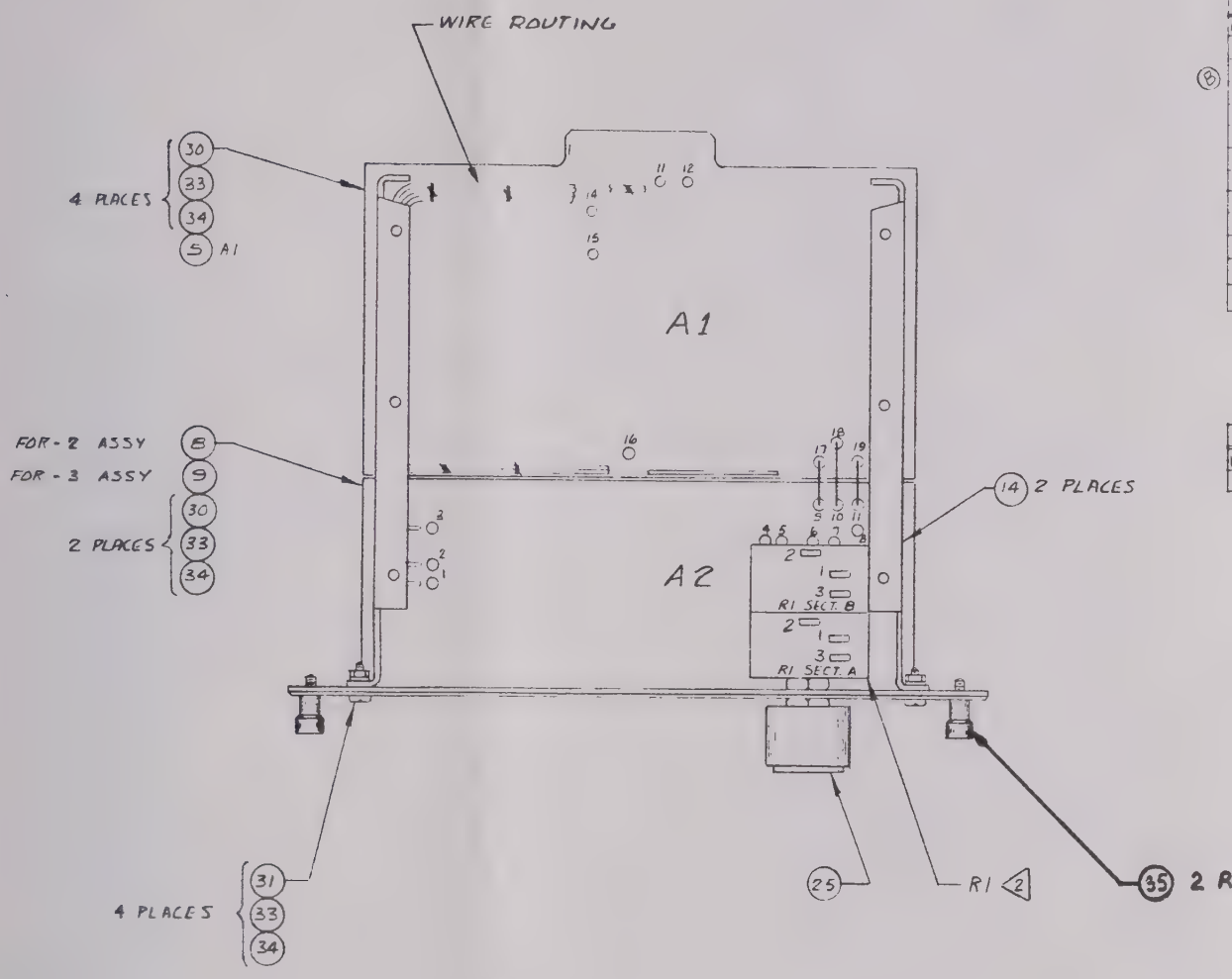
7.1 GENERAL

This section contains schematics and mechanical diagrams necessary for operation and maintenance of the 815T Series Precision Multiphase Oscillators. The schematic diagrams illustrate the circuit while the mechanical assemblies indicate the part placement.

7.2 REFERENCE DESIGNATIONS

Partial reference disignators are shown on schematics and mechanical drawings. Prefix these reference designators with assembly and/or sub-assembly designation for the complete reference disignator. For example:

Assembly/Sub-Assembly	Component	Complete Designation
A1	C30	A1C30
None	T1	T1
A2	R1	A2R1



3. INSPECT GROUND CONTINUITY FROM FRONT PANEL CAPTIVE SCREW TO EACH SIDE RAIL, AND ON 200Hz OR LOWER FREQUENCY UNITS, CHECK TO GROUND SHIELD.

-2 ASSY - 2 PHASE (USE WIRING TABLE 2)
-3 ASSY - 3 PHASE (USE WIRING TABLE 2 & 3)

<2> INSTALL NUT ON POT. SIDE (BEHIND F/P) PRIOR TO INSTALLATION.

1. FOR INNER CONNECTION DIAGRAM, SEE DWG D4815-070.

NOTES: (UNLESS OTHERWISE SPECIFIED)

WIRING TABLE 1 (FOR 1φ UNITS)

#	FROM	TO	WIRE	REMARKS
	A1-14	A1-15	24 AWG	BUSS

WIRING TABLE 2 (FOR 2φ UNITS)

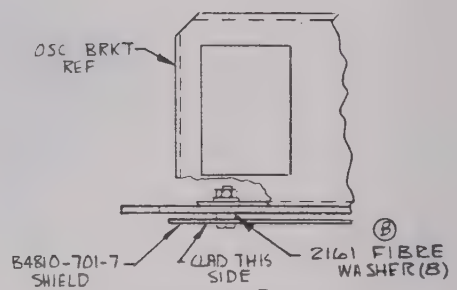
#	FROM	TO	WIRE	REMARKS
	A1-12	A2-2	24 AWG	BLK
	A1-15	R1-B-3		BRN
	A1-14	A2-1		RED
	A1-16	A2-8		ORN
	A1-17	A2-9		BUSS
	A1-18	A2-10		BUSS
	A1-19	A2-11		BUSS
	A2-6	R1-A-3		YEL
	A2-5	R1-A-2		GRN
	A2-7	R1-B-1		BLU
	A2-4	R1-B-2		VIO
	R1-A-1	R1-B-1	24 AWG	BUSS

WIRING TABLE 3 (FOR 3φ UNITS)

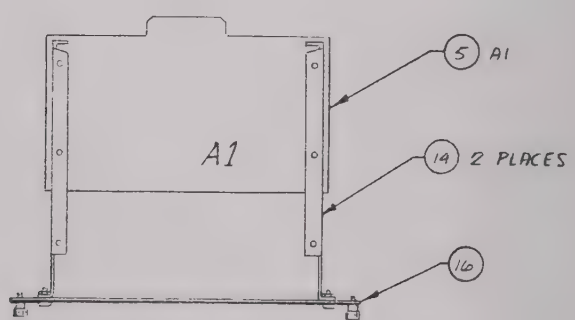
#	FROM	TO	WIRE	REMARKS
	A1-11	A2-3	24 AWG	GRAY

REVISIONS

REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
D		ADD ITEM #35,			4/62	J.L.



VIEW A
SIDE VIEW - FOR UNITS WITH 200Hz OR LESS FREQUENCY.



-1 ASSY - SINGLE PHASE
(USE WIRING TABLE 1)
SCALE 1:2 (FOR HARDWARE CALLOUTS SEE -2 & -3 ASSEMBLIES)

FOR PARTS LIST SEE PL 4815-400

ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE

REQD PER ASSY

DIM IN INCHES TOLERANCES XXX = .010 XX = .03 X° = 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓
DWG SIZE D

TITLE: SERIES 815T OSCILLATOR, 1φ, 2φ, & 3φ ASSY

MODEL 815T
RELEASE
CHECKER
DESIGN
DRFTSMN

PURCHASING
PROJ ENGR
CHF ENGR

CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA
CONTRACT NO
CODE IDENT 16067
DWG NO D4815-400
REV D
SCALE FULL & NOTED
SHEET 1 OF 1

DASH NO | QTY REQD | NEXT ASSEMBLY | EFF ON | AUTH

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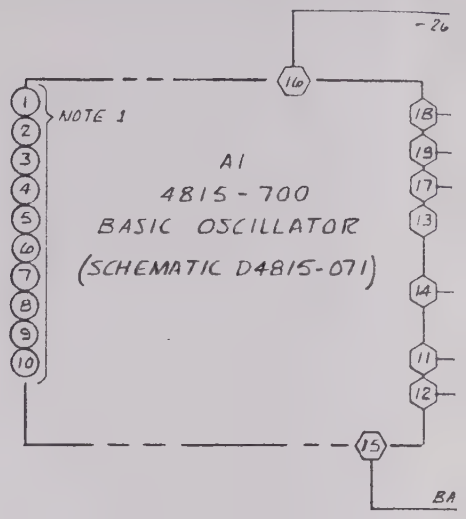
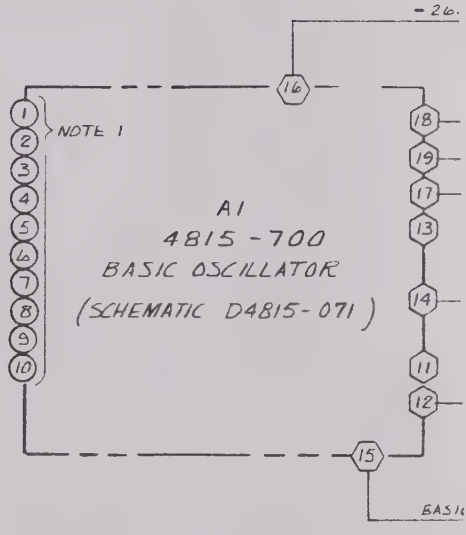
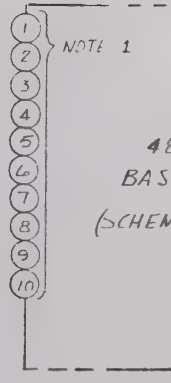






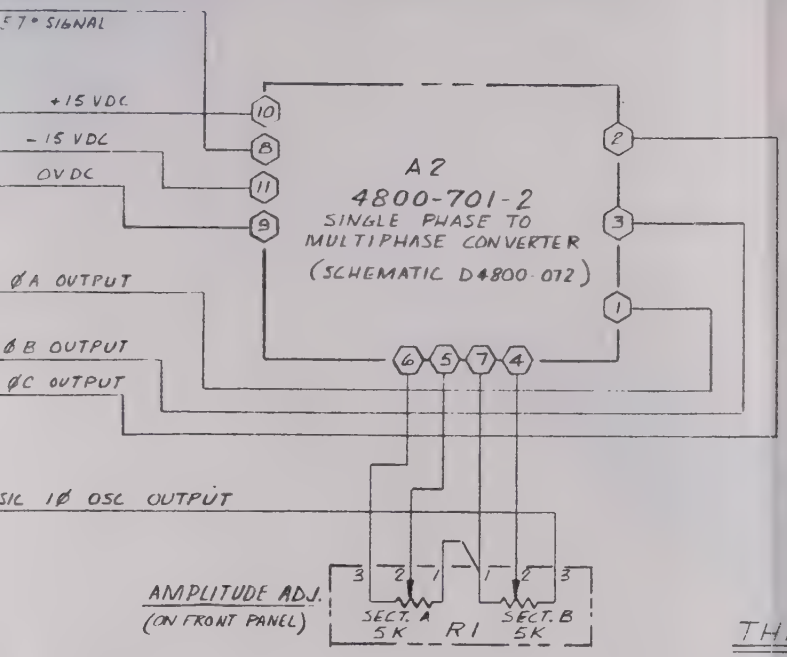
3. FOR TOP ASSY, SEE DWG D4815-400.

2. (X) INDICATES TIE POINT EYELET ON P.C. BOARD.

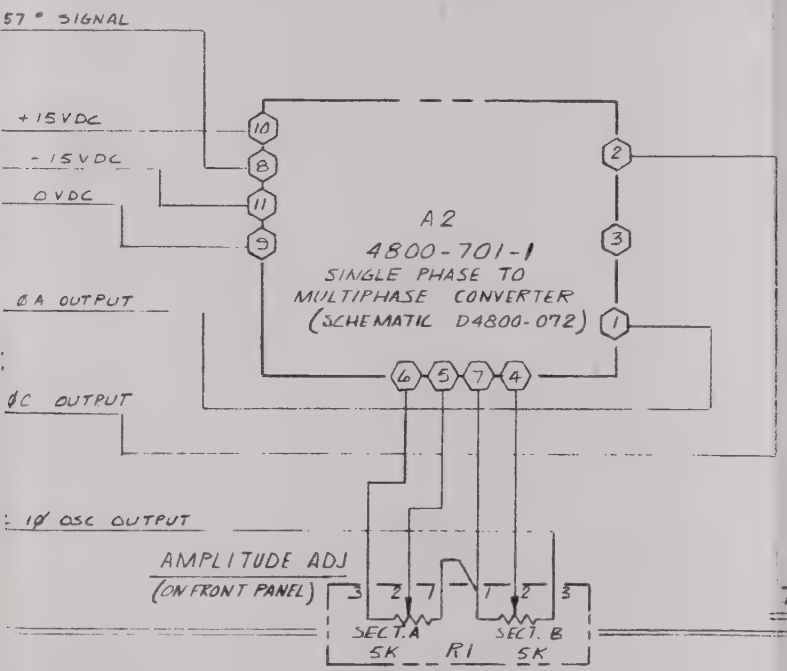
1. (X) INDICATES CONNECTOR CONTACT.

NOTES: (UNLESS OTHERWISE SPECIFIED)

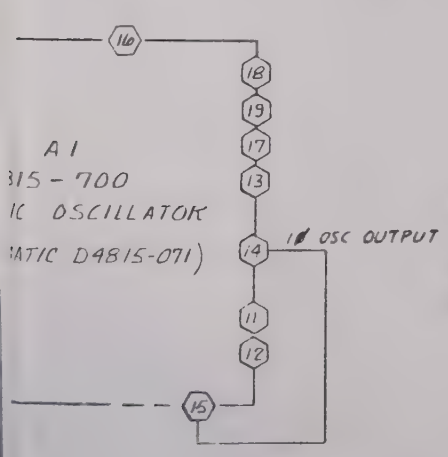
REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
A	CC	26.7 [illegible] 26 A2			5/24/76	JC



THREE PHASE



TWO PHASE



SINGLE PHASE

ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE
REQD PER ASSY							

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓

DWG SIZE D

TITLE: INNER CONNECTING DIAGRAM 1Ø, 2Ø, & 3Ø

CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

MODEL 815T

CONTRACT NO

CODE IDENT 16067

DWG NO D4815-070

REV A

SCALE NONE SHEET 1 OF 1

RELEASE					
CHECKER	[illegible]	6/1/70	PURCHASING		
DESIGN			PROJ ENGR	[illegible]	
DRFTSMN	Martin	5/25/70	CHF ENGR	[illegible]	7/6/70

DASH NO	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

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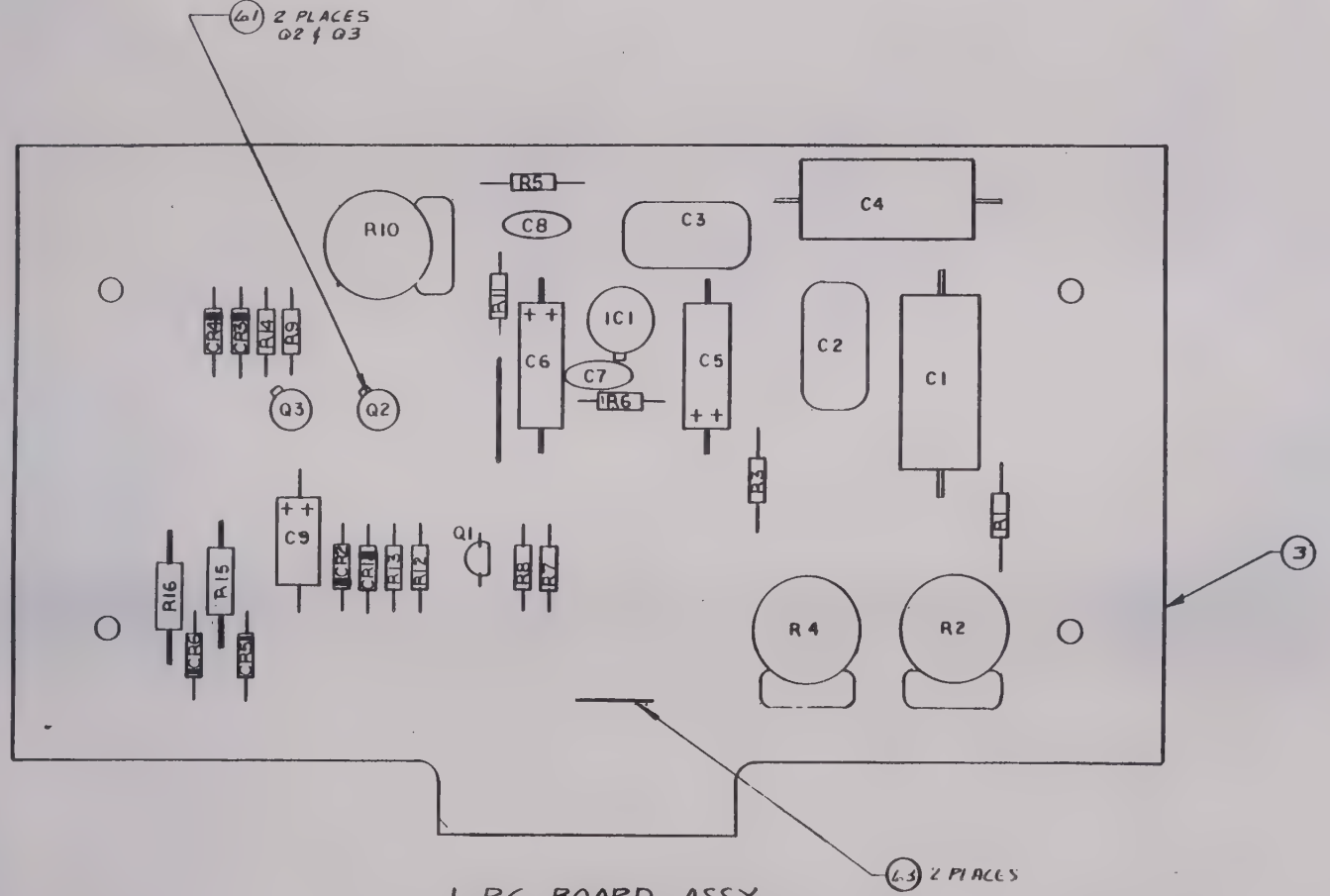
D4815-070 A

CALICO P-360

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
		SEE SHEET 1.				



-1 P.C. BOARD ASSY
VIEW COMPONENT SIDE

C4815-700 A

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
		PL 4815-400	PARTS LIST	SEE SHEETS 4 THRU —				

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓
DWG SIZE C

TITLE P.C. BOARD ASSY, BASIC OSC A1

MODEL 815T

CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

CONTRACT NO. | CODE IDENT 16067

DWG NO. C4815-700 | REV A

SCALE 2X | SHEET 2 OF —

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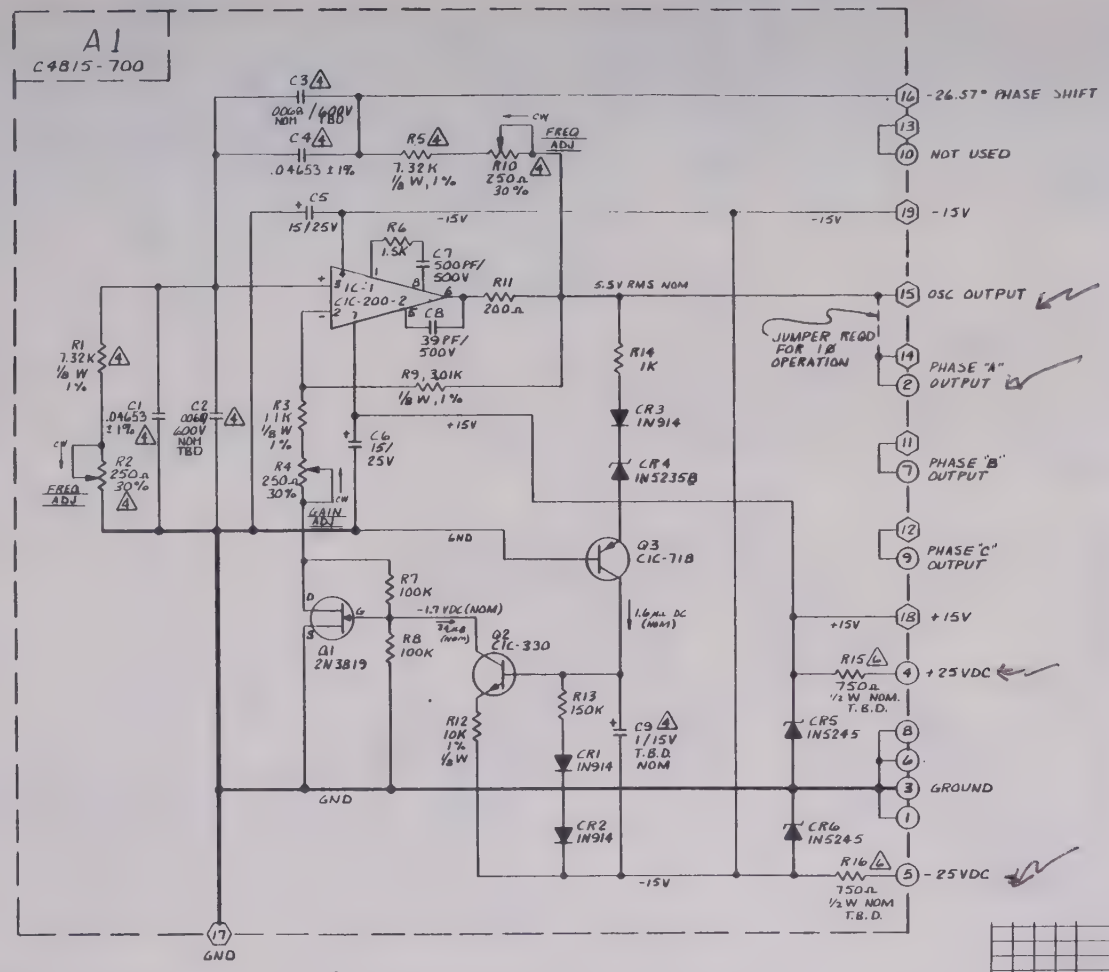
RELEASE
CHECKER [illegible] 6/11/70 PURCHASING
DESIGN PROJ ENGR
DRFTSMN MARTIN 5-20-70 CHF ENGR

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH
-1	1	4815-400		

1. FOR SCHEMATIC DIAGRAM, SEE DWG D4815-071.

NOTES: (UNLESS OTHERWISE SPECIFIED)



REVISIONS					
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
A	DC	C1&C4 was .04653 1%				
B	DC	26.57° was 26.6°				
C		ECO 1111 AB 782				
D		V19 WAS SIR DUH 0422	AB	5214		
E		ECO 1155 AB 12-83				

3 (X) INDICATES CONNECTOR CONTACTS.
(X) INDICATES EYELET TIE POINT ON P.C. BOARD.

2. FOR P.C. BOARD ASSY, SEE DWG C4815-700. FOR 2Ø & 3Ø INTERCONNECTION, SEE DWG D4815-070. FOR FINAL ASSY, SEE DWG D4815-400.

1. RESISTORS ARE ½W, 5%. VALUE IN OHMS.

NOTES. (UNLESS OTHERWISE SPECIFIED)

L FOR 1Ø NOM. VALUE IS AS SHOWN. FOR 2Ø/3Ø NOM. VALUE IS 220Ω, 1W.

5. CAPACITANCE IN MICROFARADS.

4 COMPONENT VALUES ARE SHOWN FOR 400Hz OPERATION ONLY. FOR OPERATIONS AT OTHER FREQUENCIES SEE APPLICABLE PARTS LIST: "FREQUENCY DETERMINING PARTS LIST".

ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE
REQD PER ASSY							

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30' BREAK ALL SHARP CORNERS & EDGES EXCEPT SURFACES ✓ DWG SIZE D

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTITUTE AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

TITLE: SCHEMATIC DIAGRAM, BASIC OSCILLATOR

CALIFORNIA INSTITUTE CORP. SAN DIEGO, CALIFORNIA

MODEL 815T

CONTRACT NO. CODE IDENT 16067

RELEASE

CHECKED PURCHASING

DESIGN PROJ. ENGR

DRAFTING CHF. ENGR

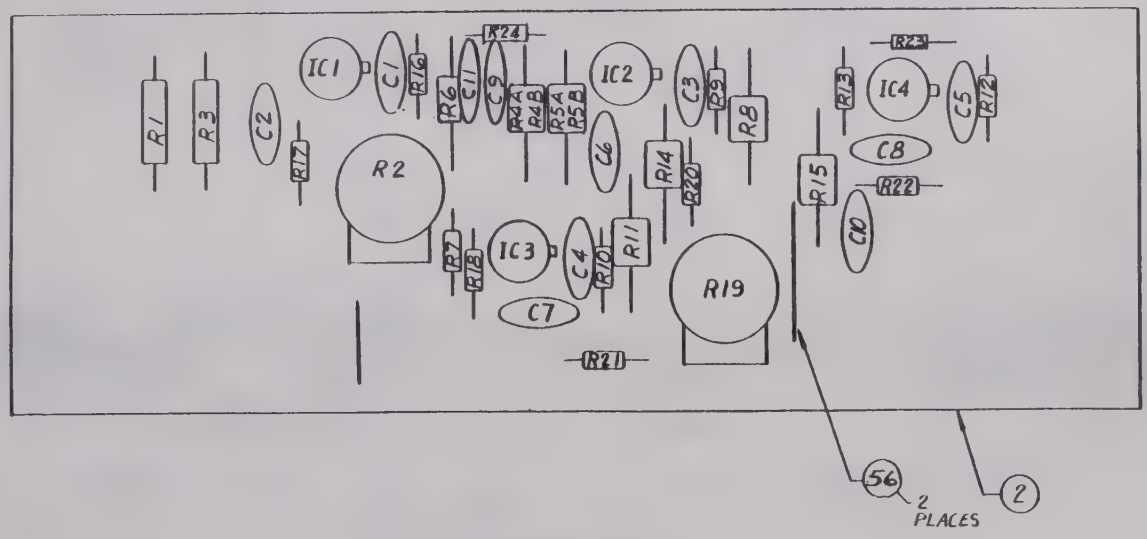
DWG NO. D4815-071 REV E

SCALE NONE SHEET 1 OF 1

CHANGE	QTY	NEXT ASSEMBLY	AUTH
REF	4815-701	815T	EFF ON

D4815-071 E

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD



-1 P.C. BOARD ASSY
VIEW COMPONENT SIDE
A2

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
-1		PL4800-701	PARTS LIST	SHEET 4 & 5				

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'
BREAK ALL SHARP CORNERS & EDGES "MACH SURFACES" ✓
DWG SIZE C

TITLE SIN. 11 PHASE TO MULTIPHASE CONVERTER P.C. BOARD ASSY

MODEL 800T

RELEASE		
CHECKER		PURCHASING
DESIGN		PROJ ENGR
DRFTSMN	9/19/	CHF ENGR

CALIFORNIA INSTRUMENTS CORP
SAN DIEGO, CALIFORNIA

CONTRACT NO. | CODE IDENT 16067

DWG NO. C4800-701 | REV E

SCALE 2:1 | SHEET 2 OF 5

DASH NO	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

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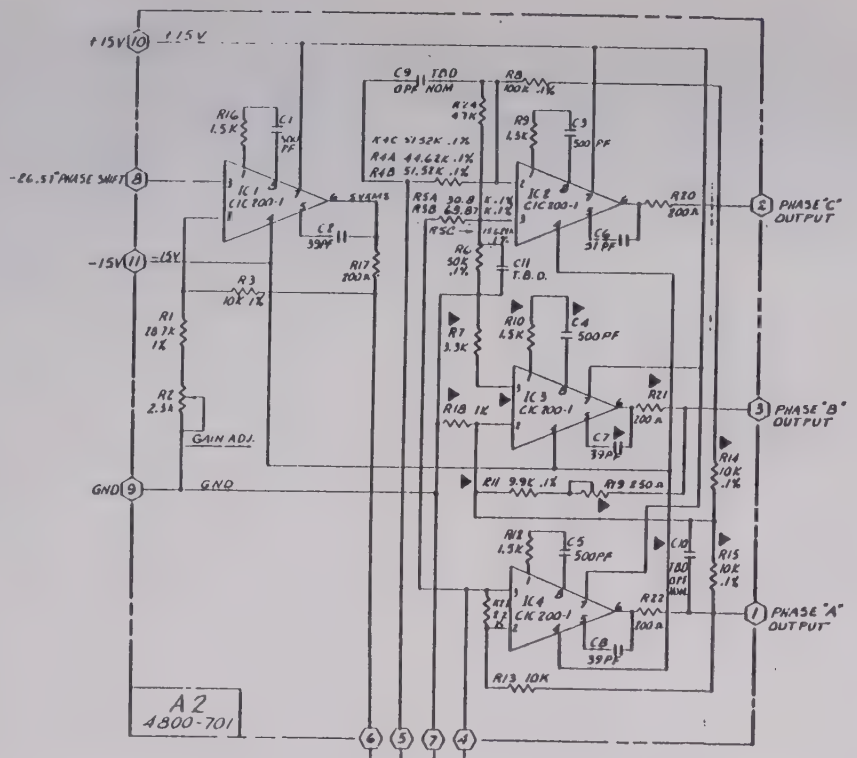
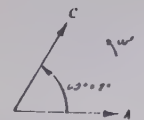
1. FOR SCHEMATIC DIAGRAM SEE DWG. No. D4800-072

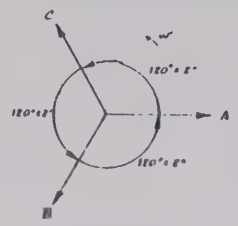
NOTES: (UNLESS OTHERWISE SPECIFIED)

C4800-701 E





VECTOR DIAGRAM FOR THREE PHASE OPEN DELTA VERSION OF OSCILLATOR



VECTOR DIAGRAM FOR THREE PHASE VERSION OF OSCILLATOR

VECTOR DIAGRAM FOR TWO PHASE VERSION OF OSCILLATOR

8. FOR INNER CONNECTING DIAGRAM SEE DWG "D4800-070 (FOR 20/200Hz) AND "D4800-074 (FOR 45/75Hz & 300/500Hz).
7. (8) INDICATES TIE POINT (EYELET) ON P.C. BOARD
6. ALL REF DES ENDING IN '6' ARE FOR 3ø OPEN DELTA OPERATION.
5. ALL REF. DES. ENDING IN '8' ARE FOR 3ø OPERATION.
4. ALL REF. DES. ENDING IN 'A' ARE FOR 2ø OPERATION.
3. ▶ NOT USED FOR TWO PHASE OSCILLATOR OR 1 OR 3ø OPEN DELTA OSCILLATOR.
2. FOR P.C. BOARD ASSY SEE DWG "4800-701
1. RESISTORS ARE ¼W 5%

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS					
REV	AUTH	DESCRIPTION	ZONE	ECP OR	DATE	APPD
A	LC	(ECP No. 78)			9/78	
B	LC	INC BO 2628 & 2629 ECP No.			9/78	
C	LC	INC BO 401			11/78	
D	LC	INC BO 428			11/78	
E	BP	DELETED R17 & R20 INCREASED R6			12/78	
F	BP	RE-STYLE DWG.			6/79	

ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES
REQD PER ASSY						

DIMENSIONS IN INCHES
TOLERANCES
.XXX = .000
.XX = .00
.X = .0
ANGLES ± 30'
BREAK ALL SHARP CORNERS & EDGES
MACH. SURFACES ✓
DWG SIZE D

TITLE: SCHEMATIC DIAGRAM, SINGLE PHASE TO MULTIPHASE CONVERTER

MODEL 202T TWO & THREE PHASE

DRAWN
CHECKED
ENGR
APPROVED

CAGE CODE 16067

DWG NO D4800-072 REV F

SCALE — SHEET 1 OF 1

REPLACEABLE PARTS

7.1 GENERAL

This section contains ordering information and complete list of replaceable parts. Parts are listed by major assembly in alphanumerical order of their reference designators. Description, manufacturers' part number, manufacturers' code ident number (see Appendix A for list of manufacturers), and California Instruments' stock number are indicated.

7.2 ORDERING INFORMATION

In order to provide our customers with prompt service on replacement parts, please provide the following information, when applicable, for each part ordered:

a) Model number and serial number of the instrument.

b) California Instruments part number of the sub-assembly where component is located.

c) Component reference designator.

d) Component description.

e) Component manufacturer's number and code ident.

f) California Instruments stock number.

All replacement parts orders should be placed with California Instruments, Division of Amstar Technical Products Co., Inc., San Diego, California, 92111-1266.

7.3 COMPUTER GENERATED PARTS LISTS

The following information is included as an explanation of the computer formatted parts list column.

7.3.1 "Seq. No." - Sequence number; the reference designator or the component, or (if there is no reference designator) the balloon number (bubble or "find" number) on the face of the assembly drawing or the top assembly drawing. They are listed in alpha-numerical order.

7.3.2 "Component Item No." - This is California Instruments part number. Please use this number when ordering spares.

7.3.3 "Description, Truncated" - A brief description of the item. Abbreviations are per MIL-STD-12 or industry accepted standards.

7.3.4 "Engineering Drawing No." - This is used for one of the following:

a) The document/specification number generated by California Instruments to control the part.

b) The generic part number (military specification or industry accepted standard).

c) The primary vendor's catalog part number. An asterisk at the end of the number indicates number is longer than that shown (contact California Instruments if the full number is required).

7.3.5 "Vendor" - This is the FSCM code identification (see Appendix A).

7.3.6 "Quan" and "U/M" - The requirements per unit of measure such as: "2 each"; "1 lb."; "4 oz."; or "6 SI" (square inches).

From

California Instruments

A Division of Amstar Technical Products Company, Inc.

5150 Convoy Street
San Diego, California 92111

Attn: Customer Service

RMA NO. _____